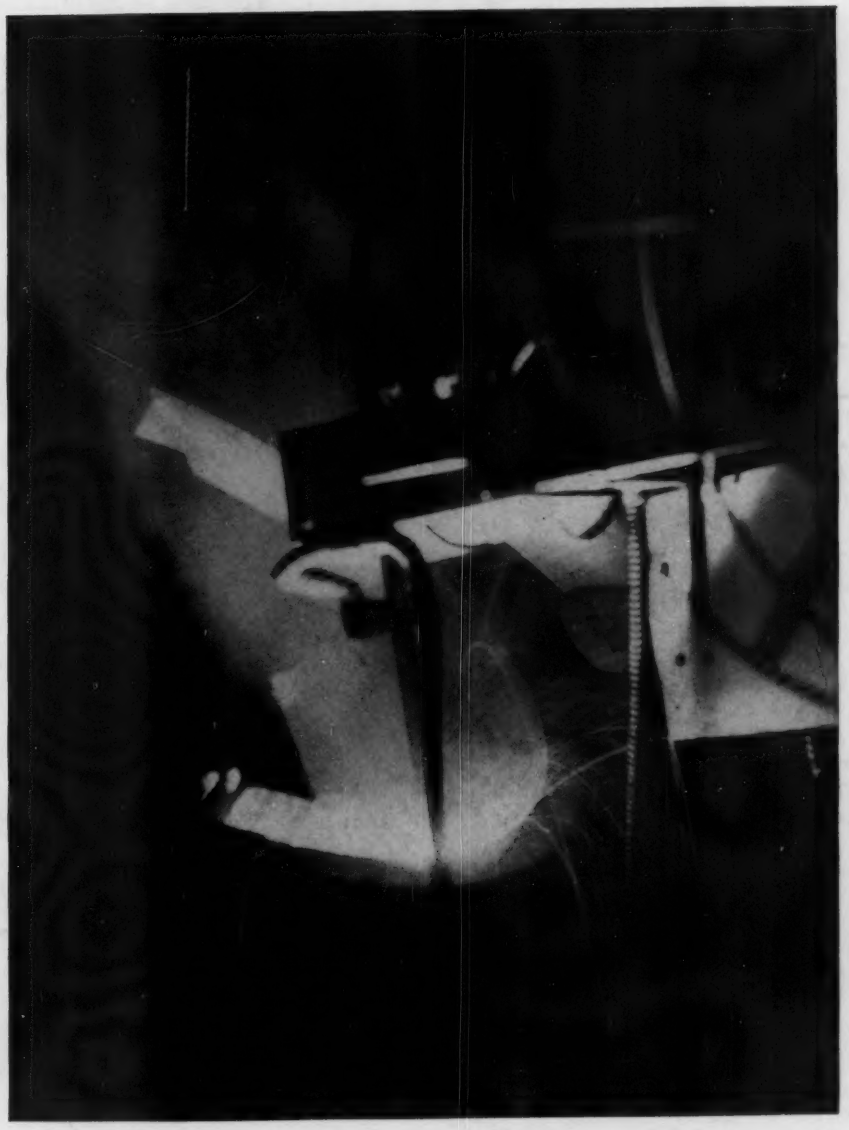
THE TECH ENGINEERING NEWS



FEBRUARY, 1933 VOLUME XIV, NO. 1
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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The moment a crime is reported to headquarters, the desk-sergeant reaches for his Radio Telephone . . . puts clearly spoken instructions "on the air." *Instantly* radio-equipped police cars start racing to the scene . . . criminals are often caught in the act! In twenty-seven cities, Western Electric Police Radio Telephone is speeding-up the war on crime, making get-a-ways harder. Producing new kinds of sound transmission apparatus to meet new needs is an interesting outgrowth of Western Electric's 50 years of experience in manufacturing telephone equipment.

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The TECH ENGINEERING NEWS

Volume XIV CAMBRIDGE, MASS., FEBRUARY, 1933 Number 1

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TALL TIMBERS

THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME XIV | FEBRUARY, 1933 | NUMBER 1

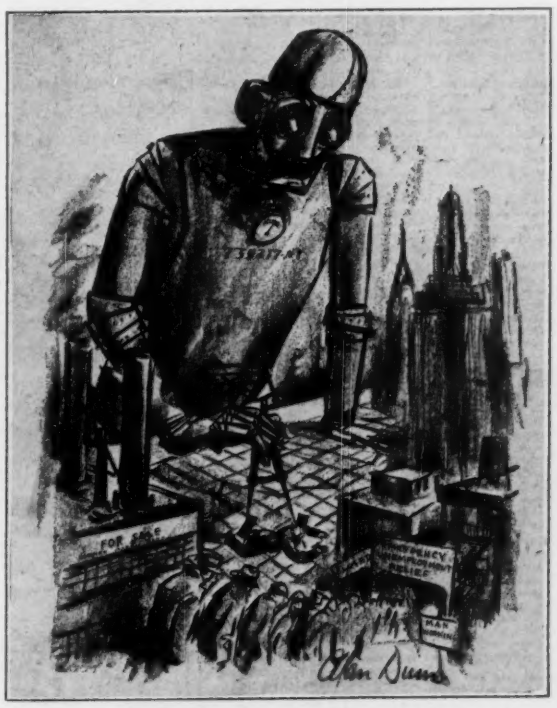
AN ENGINEERS' UTOPIA?

An Economist's View of Technocracy

By RALPH E. FREEMAN

Associate Professor of Economics, Massachusetts Institute of Technology

LIKE a person who retires within himself to build a world of fancy, where his suppressed longings and impulses can find complete satisfaction, so society in times of depression seeks relief through the contemplation of dream-worlds from which injustice and poverty have been banished. Utopias are created in periods of anxiety and doubt when the pillars of the social order seem to be crumbling. The troubled present brings forth Technocracy. It comes at a time when men and women, having lost faith in the old institutional idols, are looking for new gods to worship; it assumes a form calculated to make a strong appeal to those whose lives have been revolutionized by mechanical inventions and whose minds have been enthralled by the magic of modern science. It has been aptly said that this new god is only a scarecrow "clad with grandfather's discarded suits" and "stuffed with statistical straw that has been kicked around the barn floor for a long time." And yet in the eyes of a world fascinated by the wonders of science and looking for a sign the scarecrow seems alive and "the rustling of its straw-stuffed limbs gives us creepy feelings."



The New York World Telegram

But, whether or not Technocracy has been accepted by a considerable number of people, it has made a noise sufficiently loud to startle many of them into thinking furiously about the foundations of our social institutions. That much, at least, must be placed to its credit. It has stimulated interest in economics, for example, and has supplied the economic practitioners with some chocolate coating to camouflage their pills. People will swallow a certain amount of economic theory in the guise of an attack upon Technocracy, which in less attractive form they would refuse to touch. Were it not for the mental condition created by these fearful Cassandras of Technocracy, I would not have been asked by the editor of this publication to explain my conviction that the doctrine is based upon a misconception of the rôle of the machine in modern life and upon a misunderstanding of certain fundamental economic principles.

1. A Criticism. As far as can be determined from newspaper reports, magazine articles and the few books that have appeared on the subject, the sponsors of Technocracy have a threefold purpose: to criticize the existing industrial order, to analyze it, and to prescribe a radical program of reform. Like most Utopias, Technocracy is strongest in criticism. With unerring precision its protagonists have located the weak spots in our economic system. We are inefficient in many of our productive operations, wasteful in our marketing methods and unintelligent in the uses to which we put the goods and services created. The existence of widespread poverty in the presence of surplus food and clothing, the tremendous energy devoted to competitive advertising and selling, and the ostentatious spending of the rich — these are exposed in scathing terms. Workmen are unable to find employment; business leaders and politicians are unable to give them jobs. We have a credit system that permits the piling up of burdensome debts and a money system in which the standard of value is subject to disconcerting change.

2. An Analysis. This eloquent indictment may be listened to with interest; there is nothing new about it; there will be few dissenting voices. It is when they pass from criticism to analysis that the technocrats seem to lose their bearings. This is strikingly apparent in their

(*Continued on page 18*)

Gold: Its Relation To Civilization

By WALTER H. NEWHOUSE
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Massachusetts Institute of Technology

TINY grains of yellow metal are being sought for on many a stream and gravel bank from the Yukon to the equator. Sowbelly and beans once again furnish the motive power for the prospector with his shovel and gold pan or sluice. Gold prospecting of this kind had waned for years until mother necessity again made it popular. Men out of work, professional men without clients, college students, old-time prospectors, a varied lot, are getting results which range from good pay to nothing.

Why all this search for the gold which has been slowly worn down from the hills by the patient rivers, and concentrated here and there for man's enrichment? Man must eat. Something is better than nothing, and the daily toil is assisted by hope of a "strike" as well as by the beans and bacon.

Not only the jobless, but also mining companies, are searching for gold. For a depression is on the world. Of all the metals gold alone is now giving due good reward to the finder. In effect the price of everything but gold has dropped. Rock that was for all practical purposes worthless in 1929, may now pay dividends. Much more labor and supplies can be bought today for one dollar, than that dollar would produce in 1929, and, therefore, rock with less gold in it can at present be mined at a profit.

Of about twenty-one billion dollars worth of gold produced since 1493, approximately half has been fabricated, lost or hoarded, and the remaining eleven billion is being used in the money systems of various countries. The annual production is about four hundred million dollars. There has been expressed a fear that we would not be able to maintain our present production rate, and that in a few decades a sharp decline would take place. How soon and how abrupt the decline will be are matters of very considerable interest to thoughtful people. The answer is bound up in a number of variables, to each of which no very definite limits can be assigned. The most important of these variables include ore reserves and new discoveries, technical changes in mining and recovering the gold, and lastly, and by no means least important, political activities.

The world has been well scoured for gold. From very early in the history of man, it has been one of the most desirable metals. As a consequence of this fact, and because it is easily found and recovered in certain types of occurrence, the older settled countries have long since yielded their main supply to mankind.

Gold is occasionally found in nature chemically combined with other elements, such as tellurium or selenium, and also in small but often economic amounts in sulphides, such as those of iron or iron and copper. At other places large deposits of it are found, where it is present as the native metal distributed in small amounts through quartz. A gold deposit of this kind is frequently in the form of a vein or tabular mass, which may extend down from the earth's surface for a few hundred or some thousands of feet. Again a large mass of rock may be interlaced by numerous small gold quartz veins only a few inches apart, and the whole mass contains enough gold so that it may all be mined.

Under certain conditions of erosion, these gold quartz veins may be slowly broken up at the surface and due to the indestructible nature of the native metal and its high specific gravity it may be concentrated in workable amounts in gravel along the streams. Such a deposit is called a placer.

Placers are easily found and worked by unskilled labor so they quickly disappear in a settled country. It was such gold that lured the forty-niners across the deserts to California. The history in California is similar to what it has been in many other places. Rich placers caused a large migration to the region, the placers were soon rifled and then the remaining lodes or veins from which the placers were derived were explored and mining began. Within a few score years the richest of these were worked out, and mining continues on only a few veins which extend down for some thousands of feet in the solid rocks. At this stage new veins or ore shoots are occasionally found, which may slightly quicken the fading pulse of production.

In the exploitation of such a gold-bearing region, the curve of production rises rapidly to a peak and then when the

Engineering and Mining Journal

No. 5 shaft of the Crown Mines, the second largest gold producer in the world, located in Johannesburg, Union of South Africa.

Hydraulic placer mining of gold along Glacier Creek in the Nome region of Alaska.

stage is reached in which only a few mines remain working on the more persistent veins, there is a marked falling off in the curve of production. The length of this cycle varies. In some of the smaller districts only one or two decades elapsed between the beginning of mining and the final falling off to a production of small amount compared to that at the peak.

Some districts produce longer, the most notable one being the Witwatersrand in South Africa, where production has been climbing since 1885.

So much for the small cycle; the important point is our present position in the cycle of world production. The effect of all the changes implied in the term "Machine Age" has been to speed up enormously the production of gold. More than half the grand total of gold produced in the past four hundred and thirty-five years has been produced in the last thirty-five years.

Before the New World was discovered Austria-Hungary produced a considerable part of the world's output. After the Spaniards' conquests in Latin America, first Colombia in the seventeenth century, then Brazil in the eighteenth, led with the other Latin American countries, swelling the total. South America held first place until 1850. Then came the important discoveries in California in 1848, in southeastern Australia in 1851; then later in the century and in the early part of the twentieth, rich finds were made at Cripple Creek, Colorado, in Alaska and the Yukon, at Goldfield and Tonopah, Nevada, in South Dakota, in western Australia, and on the Rand in South Africa. Within the last few decades Canada gained prominence with the discoveries at Porcupine and Kirkland Lake in Ontario.

Among recent discoveries are those at Noranda, Quebec, and Boliden, Sweden. These are in regions covered by glacial drift. Many more such deposits may exist since much of northern Canada and of northern Eurasia are masked by glacial debris. Elsewhere also, if we may judge by past experience, a few gold districts will be found in little explored countries, as well as new veins or shoots in the old districts.

It seems very unlikely, however, that any other deposits as extensive and containing as much gold as the Rand will ever again be found. For some years this district has been giving one-half the world's production, as much as ten important districts like Porcupine or Kirkland Lake. Obviously when the Rand begins to fail, discoveries must be made at a rapid rate, or other means be used to keep up the present production curve.

One other means of helping to keep up the production is that of technical improvements in mining and gold recovery.

The development of the cyanide process which made possible the obtaining of gold from ore that had previously not been amenable to gold extraction methods is an example of enlarging gold reserves by new technique. Improvements less spectacular than this one are constantly being made, the cumulative effects of which cannot be ignored.

It is the writer's opinion that the political-economic relations will probably be so shaped in South Africa as to delay exhaustion of workable ores on the Rand and East Rand for some decades to come. Considerable bodies of gold-bearing rock are known to exist, which cannot be worked under present economic conditions. The known amount of such reserves could doubtless be extended if there was a commercial interest in prospecting for them. At the present time the gold mines support a heavy part of the tax load of South Africa.

(*Continued on page 20*)

Gravel washing for gold on the Yuba River below Smartville, Yuba County, Calif.

Networks Over Our Land: Their Operation

By BRENTON W. LOWE '36

WHAT is the significance of the networks of poles and cables which spread like cobwebs over our land? Meshed in them are sub-stations and power plants, some dormant like sleeping spiders, others active like struggling flies—their turbines spinning the great armatures of 110,000 volt dynamos. We know that this whole system is teeming with charges of that great unknown, Electricity. We know, too, that man has trained these charges to alternate so rapidly that we cannot detect the flicker in a light when they change direction. Let us consider the practical system employed to capitalize this head butler of our modern machine age. Although it is impossible to isolate one system from another, we shall take a specific example and disregard the links which tie it into the state chain. Later we shall see how it is united into the great interstate network.

The definite division with which we are going to deal is a typical loop (a close circuit of transmission lines). It is 125 miles in circumference and is the major loop in the central New York area. We shall take as the scene of our illustration the office of the chief system's operator, which is the nucleus from which this loop is controlled. There is a calm quietness which presages the danger, death, and tragedy lurking in the thunder-storm which the radio has just announced "is beating its way down from the northeast." This report does not surprise the chief, who is sprawled behind his desk, which is in the center of a room bounded by switch-boards, meters, and numerous other indicators and recorders. Probably the reason that this report does not astonish him lies in the fact that he was a contributor to the government report which we have just heard. These reports, which record the ceiling, visibility, temperature, wind velocity, and general weather conditions, are sent in code to the state capital by the operators of those loops which lie on the major air routes. Hours ago the chief has been tipped off about the impending storm which had raised havoc with the northern lakes sector by the Saranac Lake division, which is miles to the northward.

With a lurid flash the storm announces its presence. Methodically the chief begins checking up by calling all those stations which would report to him in twenty minutes. (All station operators must report on the hour, and it is now 4.40 p.m.) He orders the "hot-line" crew (an emergency crew which works on the lines without shutting off the power) and other repair crews to stand by; all these preparations are made over private lines which run beside the poles to enable crews and patrolmen to report.

The first blow is struck; the red luminous needle on the production graph dips, and all the lights dim. That blow cross-circuited the lines, but the ever faithful oil switches opened, and cut out the bad section. Five seconds later Hamilton and Delhi tap (a small loop or line tapped on to the major loop) are reported out. A patrolman, who has been standing by, switches out the dead section and restores current to Hamilton and Delhi by feeding the juice from the other end of the loop. The loop is now open; all generating facilities are being used; there is no reserve to fall back on; they must plow through. The rush-hour is on, and the automatic station at Franklin lake has just come in to help boost up the current. The load is abnormally heavy. Shoppers welcome the glow of thousands of lights; doctors are operating on patients — racing for time; what if the light should fail? A dairy is just running the last batch before "quitting time"; thousands of dollars will be lost if this process is delayed; the milk will be sour by morning, and, although the power company will not have to make good, since damage from lightning is an act of God, such an occurrence would lower public confidence. Everything is on a narrow margin. Elevators are halfway up buildings; railroads and subways are between stops; traffic signals are controlling the potential chaos. Even the dependable Bell Telephones are thrown off balance when there is an interruption, for they are keyed to tune out transmission hum, and, when this hum ceases, the tuning apparatus works against the clearness of the phones. The maintenance of service depends on the keen, even-tempered mind behind the operator's desk. For these reasons, the turning in of graphs showing no sharp dips or breaks (these indicate interruptions) means more to these men than risk of life.

The storm seems to have spent its fury. Contact is made with the stranded crews and the work of reconstruction is begun. The chief determines which sections of the loop are dead by switching in different portions of the section that the oil switches have cut out; and then, after eliminating the sections which do not cause the oil switch to act, he marks the bad sector and instructs the individual patrolmen who have tapped into the telephone system and are awaiting orders.

But wait, the tail end of the storm is swinging around. There is a sputter over the phone and then a booming crash. The lights in the operating station go out; but immediately the emergency lights, run by huge storage batteries, flash on. A patrolman roars a request; the chief authorizes a temporary interruption, and in a few seconds a crew has removed a branch which had crossed the 33,000 volt line with the 22,000 volt distribution line. The storm rolls over after breaking a few more insulators on the high line (high tension, 22,000 volts and up).

But is this all the damage done? Let us set out to the field of action; the bad sections must be repaired. The hot-line crew arrives on the scene first since it has undisputed right of way. After travelling through two terrific hail storms, the chief reaches Stamford, a town in the heart of the Catskills exposed to the direct attack. The chief walks into the sub-station yard and just as he opens the telephone booth, a lingering flash rends the dull atmosphere; two poles from the station, a fuse fails to blow, and it arcs between the pole top and the ground; the chief puts out the fire with an extinguisher and notifies the Distribution Department. He now starts to call the central operator; but he no more than picks up the phone when a great surcharge

shoots across the gaps of the lightning arrester and announces another triumph of man. (By using choke coils through, which overcharges will not pass if they can take a straight course to the ground, man has been able to force these supercharges harmlessly into the ground.) Thus, with this last menacing flash, the storm departs to continue its destruction elsewhere. The next day we find the chief and the superintendent discussing replacement of damaged apparatus, and in the course of the conversation we learn that the chief is going on an inspection trip. Let us go with him.

As we leave the yard, we see a truck pulling a transformer into position to replace one which has been blown. These transformers at the main station are on tracks; if one blows, a spare can be hooked in. Later we see a crew removing a core from a transformer, and packing it to ship back to the factory to be rewound. Here the storm's toll mounted to five thousand dollars. Now we pass over a rutted country road and finally reach a clearing where a crew is cleaning out a right-of-way. Chemicals are being spread on the underbrush to kill it and retard future growth. Now we come to one of the old steam generator plants, and the chief explains that it is now possible to extract gas from the coal and in doing so generate sufficient heat to furnish enough steam to supply a consistent source of electricity. Outside of Norwich, we may see a queer truck with a large electric motor and compressor mounted under its roof. This is an oil filtering truck. Pure oil is an excellent insulator, but when its moisture content becomes too large it is a comparatively good conductor. Until recently the oil for the insulation of transformers had to be replaced by new oil periodically; now, however, the oil is filtered on the spot by passing it through thick blotters and filters. It is then tested and frequently is found to be a better insulator than new oil, which has been shipped long distances.

Leaving this behind, we continue, and suddenly we come around a bend, and there on the side of a hill is a beautiful sight, a substation larger than any we have seen. The noon sun beats down upon it; there are no shadows, but the black transformers stand out sharply against a background of gray lightning arrester hoods. High above them are the three-pronged horn-gap switches which remind one of cat's whiskers and serve their purpose fully as well; it is the horn-gap switch which makes possible the interlocking of systems under full load. Any other switch would burn out instantaneously, but these arc over and gradually lessen the arc until the circuit is closed. Spreading off over the hill into the distance are the glistening paths upon which Electricity treads. It is here that we gain the true significance of the loop. On the wall in the controlling office we saw the scale representation of the loop; this model had small switches which represented larger ones. We saw the representative junctions with their automatic, oil and horn-gap switches, which cut out bad sectors and allowed power to come from the other end. We saw the sketches of substations which boost up the voltage and thus cut down transmission losses. We saw generating stations and imagined their humming dynamos which replaced the losses caused by line resistance. But

(*Continued on page 17*)

Electric Light and Power. Detroit Edison Company

A One Hundred-Millionth Of an Inch

By JOHN T. NORTON
Associate Professor of Physics of Metals, Massachusetts Institute of Technology

ALTHOUGH at first sight a hundred-millionth of an inch seems to be a very minute measurement, and indeed it would be if it were necessary to measure it with a meter stick or even a micrometer caliper, nevertheless, dimensions of this magnitude are being measured in many laboratories the world over as a matter of everyday routine. Furthermore, this measurement is not approximated but really ascertained with an error of less than one part in 1,000.

The reply of the uninitiated to this statement is usually an indulgent smile and a vague remark which plainly indicates his disbelief. Sometimes, however, his curiosity gets the better of him, and he asks how such measurements can be carried out, and what their significance is. The reason for attempting such measurements is the desire to know exactly the distances which separate the atoms in a crystalline substance. The physicist, chemist, and metallurgist must know these dimensions quite as surely as the motor car manufacturer needs to know the sizes of the parts which enter into the construction of his car. Let us take as an example that large class of crystalline substances known as metals. Here we find that many of the important physical properties depend upon the way in which the atoms are packed together, and the packing can only be studied by knowing the values of the inter-atomic distances. A very simple calculation shows that these distances must be of the order of a hundred-millionth of an inch in magnitude.

The method of measuring such a small distance depends upon the use of a measuring stick whose length is of the same order of magnitude as the distance to be measured. In this case the measuring stick is the wavelength of a beam of x-rays. When x-rays are emitted by the metal target of an x-ray tube, the spectrum contains several sharp lines, the wavelengths of which have been measured with very great precision by a method which is no longer open to any fundamental criticism. The accuracy with which these values are known is comparable with our knowledge of the wavelengths of visible light, and, just as the wavelength of light is the real standard upon which all our everyday measuring scales are based, so the wavelength of x-rays is the standard of length for measuring inter-atomic distances.

About twenty years ago it was discovered that when a beam of monochromatic x-rays passed through a crystalline substance, portions of the beam were bent through definite angles. Shortly afterwards, it was shown that a very simple relation, now known as Bragg's law, connected the wavelength of the x-ray beam, the angle through which the beam was bent, and the inter-atomic distance. One needs only to measure this angle, and a simple calculation yields the desired distance. The atoms of the crystal really form a three-dimensional diffraction grating and in the same way that the spacings of lines ruled on a metal surface may be measured with visible light, the spacings of this three-dimensional grating may be measured by the diffraction of x-rays.

The measuring equipment consists of a source of x-rays and a device for measuring the angle of diffraction. The source of x-rays may be any one of a number of different forms of the x-ray tube. Some are permanently evacuated and sealed off, while others are demountable so that various metal targets may be used to provide a variety of values of the emitted wavelength. In all cases a source of high voltage, supplying from ten to twenty milliamperes at about forty thousand volts, is required.

The angle of the diffracted beam is usually measured by a photographic method. The camera consists of a light-tight holder for the photographic film of such a shape that the film is bent into the surface of a cylinder. The camera also supports the sample, in the form of a tiny rod, so that it lies in the axis of the cylinder. The x-ray beam defined by a collimating system enters the camera at right angles to the axis of the cylindrical film and falls upon the sample. Part of the rays pass through the specimen and fall on the center of the film; other parts are diffracted and recorded as narrow lines on other portions of the film. After the film has been developed a measurement of the distances of these lines from the undeflected beam enables one to calculate the angles of diffraction provided that the geometrical constants of the camera are known. These constants are best determined by calibrating with substances such as rock salt or calcite, whose inter-atomic distances are accurately known. There are many so-called "precision" types of apparatus designed to determine the angle and hence the inter-atomic distance in a sample with the greatest possible accuracy, but all operate on the same basic principles.

Fig. 1 shows a semi-commercial apparatus for this type of measurement. The cylinder in the center houses the x-ray tube which is operated by the transformer directly below it. The cylinder also contains a number of sets of narrow slits which define the rays, and in front of each slit system is placed a camera. These cameras cover only one-quarter of the complete cylindrical sur-

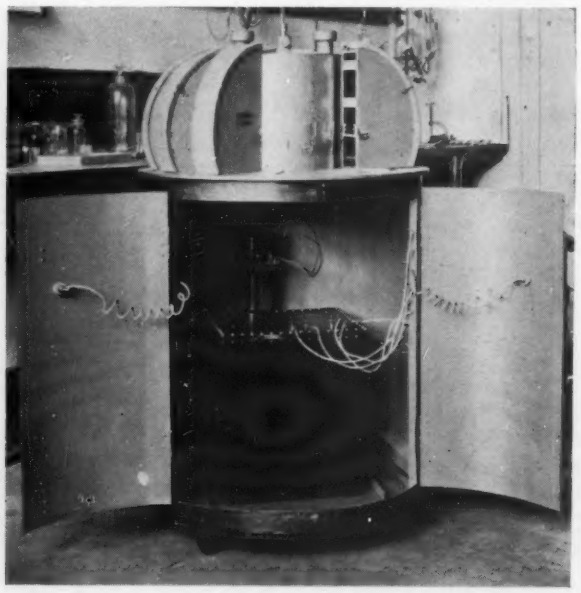

Fig. 1. A semi-commercial type of diffraction machine.

face and measure the diffracted angle up to 90 degrees. With this apparatus fifteen samples can be examined at one time. Fig. 2 shows a laboratory apparatus which is much more flexible and will give more accurate results than that shown in Fig. 1. This outfit uses a metal x-ray tube with removable targets so that a wide choice of x-ray wavelengths is available. Also several types of cameras may be employed. The tube is at the top, and the cameras are placed on the stand surrounding its base. The lower part of the apparatus contains the pumping equipment for evacuating the tube and the pipes for distributing the cooling water to the various parts. This tube and its auxiliary equipment have proved to be very satisfactory in practice and give results of the highest precision. The time of exposure for these diffraction films varies from about three to thirty hours, depending upon conditions.

In Fig. 3 are shown two photograms taken with the apparatus shown in Fig. 2. The dark lines are the traces of the diffracted x-ray beams. The upper film is the record of pure iron, while the lower represents an alloy of iron with ten atomic per cent of aluminum in solid solution. The lines have obviously shifted in position due to the formation of the alloy. Since aluminum atoms are larger than iron atoms, one would expect an increase in the inter-atomic distance, and the movement of the position of the lines shows that this has really happened. In these photograms a movement of the lines to the left indicates an increase in spacing. The actual change in the position of the right-hand line on the photogram is measured as 0.5 cm. The change in the inter-atomic distance, which is responsible for this movement, is but 0.000,000,000,14 cm. Therefore the apparatus has magnified the change in length about three and one-half billion times. Such a magnification enables one to measure those extremely small separations with an ordinary scale graduated only in half-millimeter divisions.

Perhaps two examples will suffice to show the importance of this type of measurement in the field of physical metallurgy. Pure iron when heated to redness in ammonia gas absorbs only a very small amount of nitrogen, and no particular change in physical properties is noticeable. On the other hand, if iron contains a few per cent of aluminum, the ammonia treatment causes a definite absorption of nitrogen and a noticeable increase in hardness. The question immediately arises as to what has happened, and how the nitrogen exists in the alloy. The microscope shows the presence of no new structures, and there seems to be no direct way of accounting for the change in hardness. Upon measuring the inter-atomic distances, however, one finds, as is shown in Fig. 3, that the alloy has a larger spacing than pure iron, but that after the ammonia treatment, the spacing of the alloy has decreased to that of pure iron. This can only mean that the aluminum atoms have been taken out of the solution because of a combination with nitrogen to form aluminum nitride. The remaining iron is practically pure, but distributed all through it are very fine submicroscopic particles of aluminum nitride.

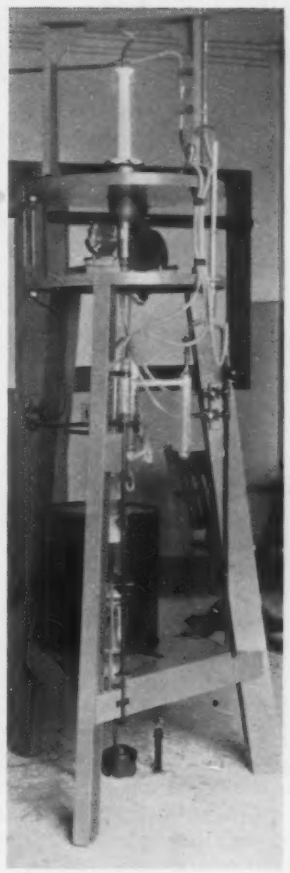

Fig. 2. A flexible model of diffraction machine designed for laboratory use.

The nitride itself is not hard, but its distribution in a form too fine to be seen with the microscope causes the hardening of the iron phase. This observation is particularly important because this process forms the basis of a widely used method of surface hardening special steels.

Another example is the application to the study of the diffusion of one solid metal into another, a phenomenon which is well known but only slightly understood at present. In some experiments now being carried out, two blocks of different metals which have carefully prepared surfaces are placed in contact, and the diffusion is caused to take place by heating them for a long period in a vacuum. One of the chief problems in this work is to determine the proportions of the two metals at various depths in the diffusion zone. Ordinary analytical methods cannot be used because this zone is very thin, and samples cannot be removed from it. It is possible, however, to measure in the specimen the inter-atomic distances at various depths into the diffusion zone and to compare these values with the spacings of similar alloys of known composition. In the case of the two metals chosen, the value of the spacing changes almost linearly with the composition. These measurements, therefore, provide a method of analysis which, although it does not give very high precision, will undoubtedly supply the desired information.

It is obvious that the distances here considered are too small to be ever seen by the eye even when the most powerful microscope is used, and the question arises as to whether these measurements really represent the quantities which we really think they represent. There are, of course, in this world very few things of which we can be absolutely certain. Nevertheless, in this case there is a great deal of contributing evidence, all of which confirms the basic idea. Consider a single example. From the law of Avogadro, familiar to every beginner in chemistry, it is possible to determine the number of atoms in a unit mass of a substance. From the measured density the volume associated with a unit

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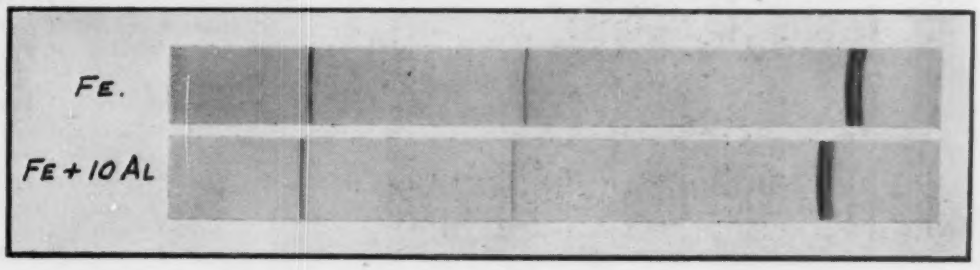


Fig. 3. The upper film is the record of the inter-atomic spacings of pure iron. The lower represents the spacings in an alloy of iron and aluminum.

Lumbering: The Modernization Of an Old Industry

By JOHN P. WALSTED
Assistant Professor of Physical Metallurgy
Massachusetts Institute of Technology

IN California, Oregon, Washington and British Columbia there survives one of the older industries, *i.e.*, lumbering. This industry, to the uninformed, is full of mystery, adventure, and romance. Like so many other industries the mystery is only in that it is carried on in places where there are no seats on the side line. Modern logging is an engineering enterprise in which machinery plays an important part.

In the Pacific northwest the timber is mostly douglas fir, although spruce and hemlock are by no means unimportant. Western red cedar, which is highly prized as shingle material, is also found, and there are a few stands of white cedar used for moth-proof chests and closets.

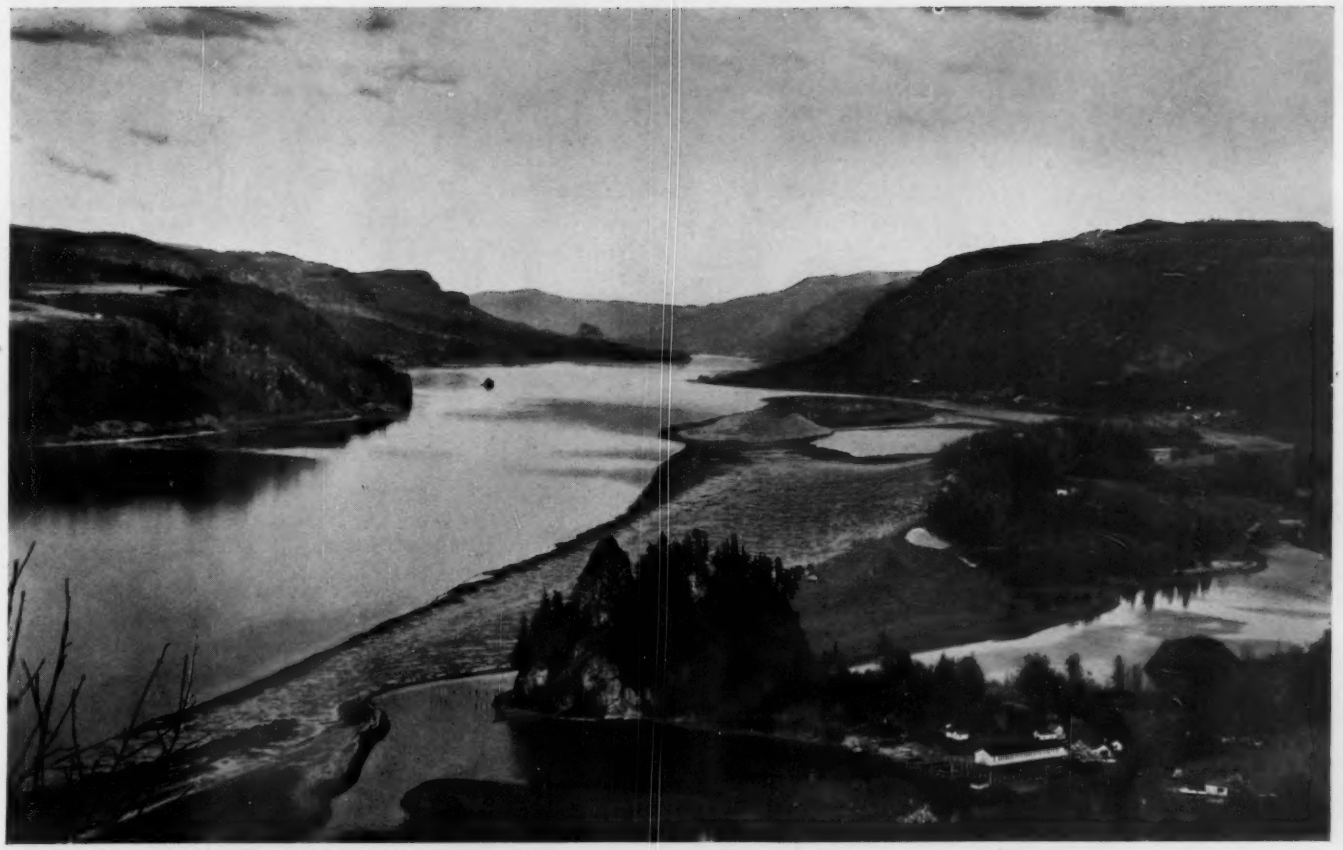
In opening a new area for cutting a survey must first be made. Timber cruisers are sent into the woods to survey the stand of timber for kind, quality and quantity. General features of topography influencing the logging operation are also briefly examined. After a few years experience these men become very skillful in estimating the amount of lumber in any given area by the average size of trees and the average number per unit area. Even though the stand will vary widely in thickness of growth and size of trees, the accuracy of their reports is surprising.

After the cruisers have completed their work, logging engineers survey the ground to lay out the plan of campaign. A camp site is selected. Main line railroads, switches, and spur tracks are surveyed. This preliminary surveying is done with the object of minimizing the cost of operation. The main line of the railroad must have as few cuts, fills, and bridges as possible.

When the surveys are completed actual operations begin. With the completion of the first few hundred feet of railroad into the woods, the camp becomes a beehive of activity, and the operations are put on a production basis.

The first step in the production of lumber is the falling of the timber. This requires semi-skilled labor and much brawn. The men, one of whom must have had considerable experience, work in pairs. A saw cut is first made on the side toward which the tree is to fall. The undercut is then completed with the axe, leaving a V-shaped notch in the side of the tree. The saw is started from the opposite side and sawing continued until the tree starts to fall. From then on it is everyone for himself, and the devil take the hindmost. The saw is quickly thrown aside and both men jump behind trees to protect themselves from flying knots, which are capable of permanently crippling anyone whom they strike. It often happens that unfavorable winds or other circumstances make it impossible to bring down a tree by such a simple procedure as outlined. In this case, wedges are

American Forests



driven in behind the saw to support the weight. When the saw is nearly through to the undercut, these wedges are driven deeply enough to tip the tree over.

When the tree is down it is marked off and cut into suitable lengths by the "buckers." The buckers, who work singly, have no "afternoon tea" job. Besides the heavy work, it is dangerous. The bucker can stay on the uphill side of a tree so that the log he cuts will not roll down on him, but he cannot always predict what the "fool killers" will do. The fool killer is an invention of nature, designed to torment and aggravate all loggers. There is on the Pacific slope a variety of maple that grows as a vine. Its stem is about the size of a man's arm and is as tough as whipcord. It grows to a length of from twenty to fifty feet. Starting from the root, it usually grows to some height, then bends over in a graceful arc and finishes up by trailing on the ground. When a large tree is felled it bends these down flat but does not break them. Even though they are so held down for a month or more when they are released they spring back to their original positions. When a bucker clears out a place to stand alongside a tree he will, if he is a fool, sometimes cut one of these vines. The resulting kick may miss him, but if it does not then his friends will.

The fallers and buckers carry on their work at the edge of the cutting. These men are the first and second skirmish lines. The work is done by hand, experience and good judgment playing an important part. The remainder of the logging operations is done by machinery. The donkey engines need no roads. They hook onto a log and pull, thrusting aside such small logs and debris as happen to be in the way. One and one-half-inch steel cable is used for the hauling lines on these donkey engines. In order to get this heavy line back to the woods for the next log a steel line five-eighths of an inch in diameter is used as a haul-back. The donkey engine itself is wood-fired and is quite inefficient. Fuel economy, however, is of minor importance where thousands of cords of wood are left to rot after the camp is abandoned.

Once in position the donkey remains fixed until its work in that locality is completed. A haul-back line is strung out into the woods, back to a previously prepared spar tree and then to the end of the main line. By winding up the haul-back line the main line is pulled out into the woods. A log is fastened to the line by means of a short strap of steel and hauled up to the roll way. Here another engine, fitted for lifting, raises the log and places it in a railroad car. By frequently changing the position of the haul-back block a circle is cleared of down timber. This circle may be several hundred yards in diameter. When this circle has been cleared, another donkey is moved into position at the far edge of the cleared space and begins clearing the next area, the first donkey now being used to haul the logs from the yarder to the roll way. The yarder is the donkey farthest removed from the railroad. The donkey near the roll way is called the roader. When three donkeys are strung out in line the total distance covered is often nearly a mile.

Due to the roughness of the ground and the presence of many stumps, provision must be made to prevent tie ups. When the timber is being cut, a tree in an advantageous position is left standing. The high climber goes up and cuts out the top at a distance of one hundred to one hundred fifty feet from the ground. Blocks are hung near the top and the main line passed through. When a log is being hauled in, it slides along the ground until it strikes some obstacle. The vertical component of force due to the high lead then pulls the log up over the obstruction.

The camp itself presents an interesting picture to the visitor. Usually set in some place convenient to the main line of the railroad, it has the appearance of a small village. The bunk houses are set in rows along

(*Continued on page 20*)

The TECH ENGINEERING NEWS

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EDITORIALS

An Engineering Forum

Where outstanding technologists may present their opinion on pertinent subjects

THE TECHNOCRACY BUBBLE

TECHNOCRACY, which is telling us so little that is new and so much that is not true, is important only because of its dangerous and unsettling influence upon the credulous, the uninformed, and the millions now unemployed, and so peculiarly susceptible to specious propaganda. Whoever the Technocrats are, hidden in the deep shadow of Mr. Howard Scott, they are not "25,000 scientists, engineers and economists," and their "12-year analysis" has brought only grossly erroneous data and preposterous conclusions. They would have us believe that four hours' labor two days a week will give every family the equivalent of an annual income of $20,000 a year. As there are probably 25,000,000 families in the country this means that by working eight hours a week we can provide the equivalent of $500,000,000,000 in necessities and luxuries, whereas by working 48 hours or more a week we have heretofore been unable to develop an annual income for the country as a whole of more than $84,000,000,000, the figure for 1929.

Technocracy has much to say about the displacement of man by the machine. Most of what it says is misleading exaggeration. It has nothing to say about the millions of jobs created by technology and the machine or about the conditions of life and labor in the days of handicrafts and cottage industries.

The easy road to the millennium, according to Technocracy, is the abolition of the price system which has served the world well for some thousand of years. Just how it is to be abolished by the substitution of an energy dollar for our old friend, the dollar bill, Technocracy does not disclose.

Despite the implications of its propaganda, Technocracy is not endorsed by Al Smith or President Butler, nor has it any official connection with Columbia University. It grotesquely misrepresents the sane engineering opinion of the country.

The best antidote for Technocracy is the careful comparison of its so-called data with the actual facts. Fortunately, such comparisons are becoming increasingly available.

DR. ARTHUR D. LITTLE,
President Arthur D. Little, Inc.

DE RE SCHOLASTICA

ABOUT this time of year many a man in the Freshman Class at Technology begins to wonder whether the course in which he is enrolled is the one for which he is best fitted.

The gravity of the question into which his doubt resolves itself varies directly as the diversity of the choice; that is, there is much more ground for apprehension when the choice lies between Mathematics and Architecture than when Chemistry and Chemical Engineering are being weighed, one against the other. A real mathematician will never be happy poring over a drawing-board. The architect who studies mathematics will need a more than earthly reward to recompense him for the tortures of the calculus. For those faced with a question of such magnitude, the only advice possible is serious deliberation and consideration of all factors bearing on the question. We know our own capabilities and our own limitations; we will be the final arbiters of our own paths.

On the other hand, there is no reason for undue worry when a change does not involve marked differences in the fields to be covered. Courses offering the

same basic studies will not differ much, either in their ultimate value to the student or in the enjoyment which they offer. The negligible effect of minor differences is shown by the fact that a survey of successful engineers a few years ago placed a valuation of only fifteen per cent on technical knowledge.

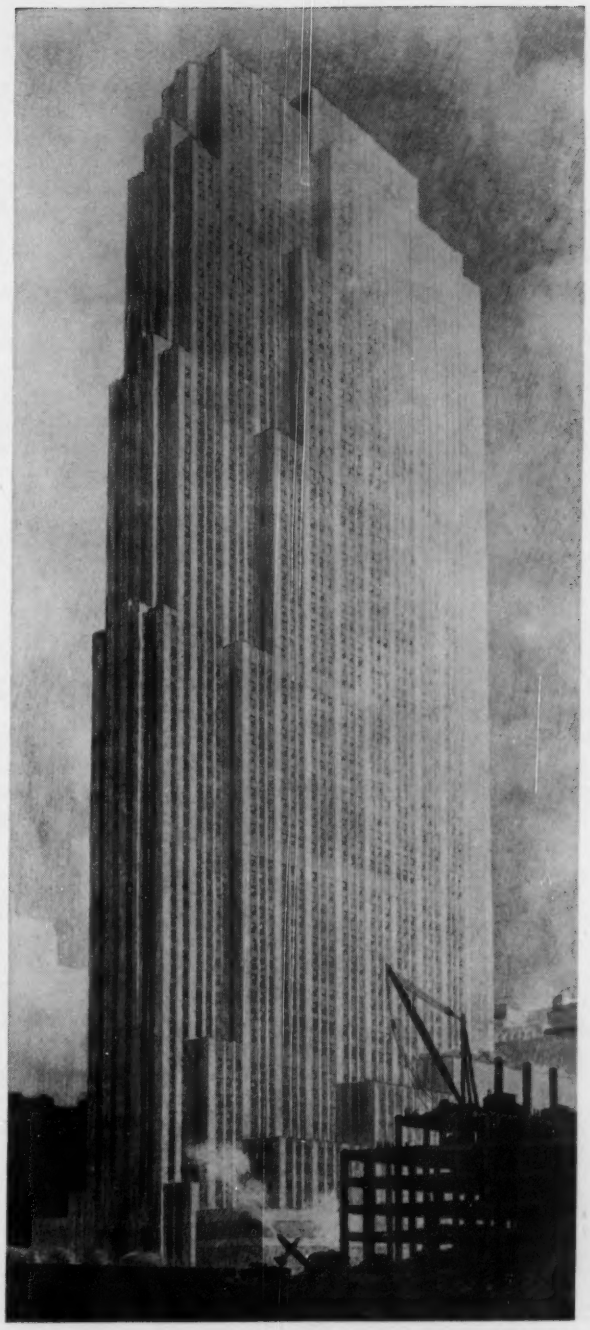
To those who cannot come to a decision, it might be well to pass on a method suggested in a Humanics class. Flip a coin. If you feel the slightest disappointment at the decision indicated, take the other course.

MORE LEISURE

FROM time to time various individuals have spent themselves in verbal effort to convince our faculty and student body that we are in dire need of more time for the studying of cultural subjects, and yet, it will be observed, none of these writings has occasioned any appreciable change in the curriculum of the Institute. In view of this fact and of the sobriety and intelligence of the Technology faculty, perhaps it would not be amiss to defend their stubbornness by disputing several of the premises and conclusions of those who have seditiously questioned the wisdom of our present administration.

First of all, are we really so disreputably uncultured? Unhappily, it is quite common for passive engineers to assume that possessors of liberal arts degrees have been officially initiated into the sanctum of culture; that they are, by virtue of their education, more cultured than engineers and scientists. John Cowper Powys, in writing on the meaning of culture, remarks that it "is nothing less than the conduct of life itself, fortified, thickened, made more crafty and subtle, by contact with books and art." When such a definition is used as a standard for weighing the relative culture of men, it becomes exceedingly doubtful if students of the liberal arts, for all their pedant nose-rubbing in the classics, surpass the Tech man who has peered into the mechanism of the universe, and who at the same time has perused during his precious leisure that in books and art which he loves.

Secondly, are we benefiting those who do not already utilize their leisure to cultural ends by giving them more? Leisure wasters are plentiful in both technical and liberal schools; in accordance with this truth, Technology deserves praise, not reprimand or correction for teaching such men (incidentally, in the majority) the habit of working hard.



Radio City, New York — *Domestic Engineers*

Furthermore, is it desirable to augment the undergraduate period by substituting a year or two more of school for the same of professional experience? And cannot our present "cultural department" be improved? Answers to these questions and numerous others are splendid reasons why the Institute is serenely maintaining its curriculum "as is," and also are good grounds for attacking the rashness of those individuals who spend a good part of their leisure worrying about getting more of it.

VISIBLE SCIENCE

FEW students, while passing through the corridors of Building Four, pause to observe any of the hundreds of portraits of great scientists which line the walls. In addition to these portraits, accompanied by brief accounts of the work of the men depicted, there are numerous illustrations of famous historic experiments, and several amusing caricatures of scientific interest.

All of these pictures have been hung along the walls to emphasize to Technology students the personal element in both pure and applied science. Were it not for the countless numbers of men who, in various ways, have given their lives and efforts to the material advancement of scientific knowledge, we should still be in a primitive state of civilization. In technical fields almost devoid of human elements, it is not at once evident that such pioneers as Galileo, Lavoisier, or Faraday were as much an integral part of science as the contributions they made.

Technological study, moreover, holds increased interest for the student if he can associate definite figures and faces with the abstract laws and theories he studies. The theory of the conservation of mass gains an element of concreteness if one looks at the picture of Lavoisier's martyr to science, who allowed himself to be sewed up in a tight-fitting rubber bag for days in order that Lavoisier might be enabled to observe the constancy of weight of the human body. Perusal for an hour of such pictures, with their accompanying explanations, is equivalent in value to reading a volume of scientific history.

VOLUME XIV

WITH this issue the Managing Board of Volume XIV takes office. An innovation is an Engineering Forum to which we hope you will contribute. In addition we earnestly solicit all suggestions and criticisms.

ENGINEERING DIGEST

Condensation of outstanding articles in the trade and scientific journals, published by special permission

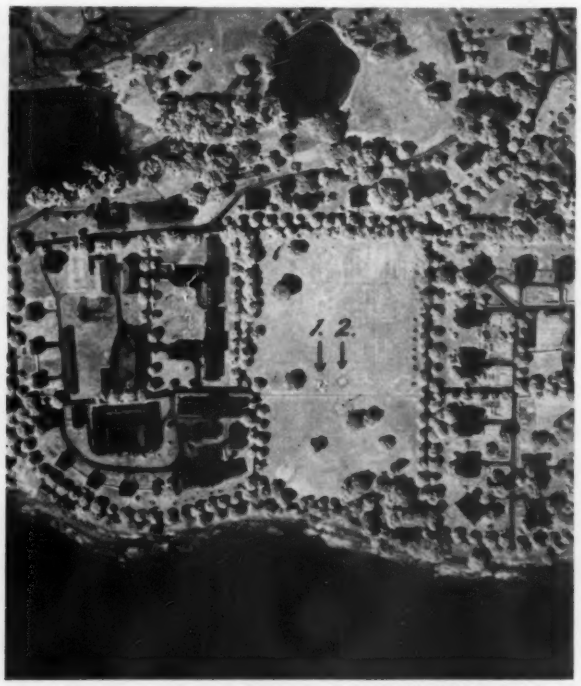
CAMOUFLAGE

The Military Engineer, *January-February, 1933*

HIDE-AND-SEEK ceases to be a childish amusement in time of war, when opposing armies are the players. Under such circumstances, it is of tremendous importance to keep the enemy guessing (and guessing wrong), concerning the location of one's guns, supply depots, and other vital spots. In Civil War days, a general could keep his army hidden from the enemy by the simple expedient of putting it behind a mountain; but with the advent of the airplane in the World War, it became apparent that guns and other equipment must be invisible from above, as well as from miles away on the ground.

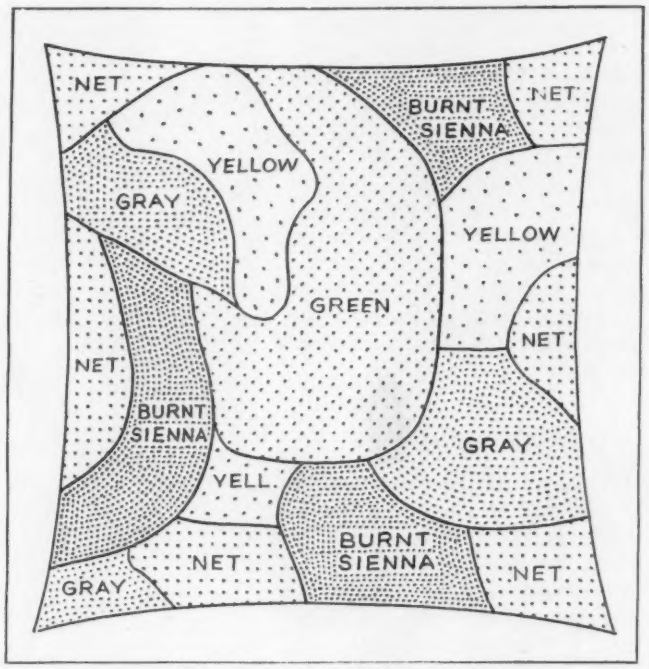
Camouflage soon made its appearance as an antidote for aerial observation, but it was not at first an entirely efficacious one. Attempts were made to imitate foliage and grass by the use of green paint which, so far as the eye could see, matched the grass and trees perfectly. The deception did not fool the photographic camera, however, nor the visual observer when he was aided by color filters. The green paint used did not reflect as much red light as natural greens, such as leaves and grass. These materials, which owe their color to the presence of chlorophyll, reflect a large amount of extreme red and near infra-red, detected by the camera, but not by the unaided eye. Improvements in green paints have brought their "spectro-photometric reflection characteristics" closer to those of the pigments found in bushes and leaves, but there will probably always be differences between natural and factory-made hues.

Recent experiments along another tack have shown, however, that even the camera can be fooled. The deception is similar to the familiar illusion that occurs in the human eye, when several colors in a painting, viewed at a distance, apparently blend together. A number of colors may be put together in a pattern so that, no matter what filter is used by the photographer,



The Military Engineer

How camouflage looks from the air; the arrows "1" and "2" point to the two experimental nets.



Large areas of cloth painted in different colors give this camouflage net the appearance of a jig-saw puzzle.

enough colors are left unaffected to cause a blending together of the pattern into a solid gray area.

How well this phenomenon translates itself from theory into practice may be seen by referring to the illustrations. The diagram above shows a net, 40 feet square, upon which have been sewed large pieces of muslin, painted in various colors. In the diagram on the opposite page is represented another 40-foot net built up in the same way, except that the pieces of painted cloth are only four inches square, forming a huge checkerboard design. The aerial photograph below shows how distinctly the different colors in the first net stand out, when viewed from above, while those in the second net blend into a neutral tone matching that of the ground.

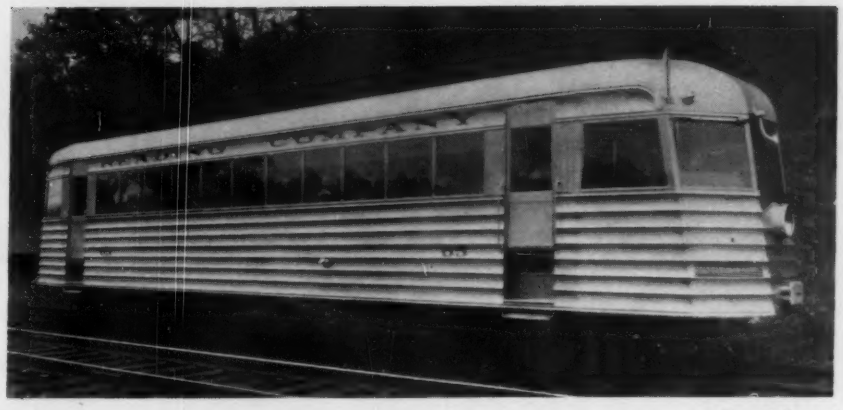
The science of concealment is being steadily expanded through experiments like the one just described. Armies have indeed become "camouflage conscious."

TRAINS ON TIRES

Transit Journal, *December, 1932*

STAINLESS steel construction, pneumatic-tired wheels, a Diesel-electric drive, doors of special design and indirect lighting are the principal features of the rail car, recently placed in service by the Reading Company. Quietness, easy riding, smooth starting, rapid acceleration and low cost of operation were among the objectives sought. The car was designed and built by the E. G. Budd Manufacturing Company of Philadelphia, under license from Michelin et Cie., of France. Although intended for suburban, main, and branch line use on steam railroads, the car is said to have possibilities also for interurban and city transit lines.

The car has an acceleration of 2 m.p.h.p.s. and a free running speed of from 50 to 55 m.p.h. From a speed of



A railroad car with pneumatic-tired wheels.

Transit Journal

55 m.p.h. it can be stopped in 400 feet or less in case of emergency. The weight of the car is about 22,000 pounds.

Each of the two trucks, framed with stainless steel, has six demountable steel wheels of Budd design, using Goodyear Michelin rail tires. In case of a puncture, a ring inside of the tire shoe supports the tire and keeps the wheel flange above rail obstructions. The tire life is estimated at 20,000 miles.

Since the pneumatic tires insulate the car from the tracks, all types of railroad signals are operated through four pairs of rocking brushes energized by an auxiliary current.

About 3,700 pounds of stainless steel were welded into a homogeneous unit for the body structure. Low weight and ample strength were obtained with this material, using the Budd "shot-welding" process. The main structural members of the body weigh about 900 pounds. Two fans with a capacity of 1 200 cubic feet per minute force air through floor ducts, giving uniform ventilation. The air is exhausted through a ceiling conduit, which also accommodates the lighting fixtures. Light is reflected against the sides of the headlining.

One-man control from either end of the car and light weight make for a low cost of operation. With a capacity of 47 seats, the operating expense is covered by a load of six passengers at three cents a mile, it is stated. Including interest on the investment, depreciation, maintenance costs and replacements, fuel oil and lubrication, but excluding the crew, the cost to run this car is said to be about 12 cents per mile.

FLEXIBLE GLASS

Chemical and Metallurgical Engineering, *November, 1932*

SHATTER-PROOF glass with the elasticity and flexibility of spring steel and known as Sekurit glass made its appearance in Germany. Unlike the shatterproof glass now in use in this country, Sekurit glass has no adhesive medium between layers. It is hardened by heat-treatment in such a manner that its transparency is not affected and its brittleness is greatly reduced. When this glass does break, it falls into small pea-shaped pieces and does not form splinters, which would cause serious injury.

The weight of three men can be carried by a sheet of Sekurit glass 1 foot by 4 feet and one-fourth of an inch in thickness, when supported at both ends. A resistance toward bending of from 27,500 to 40,000 pounds per square inch has been shown by this glass in tests conducted at the Prussian Laboratory for Testing Materials. Ordinary plate glass has a resistance to bending of from 4,125 to 8,830 pounds per square inch.

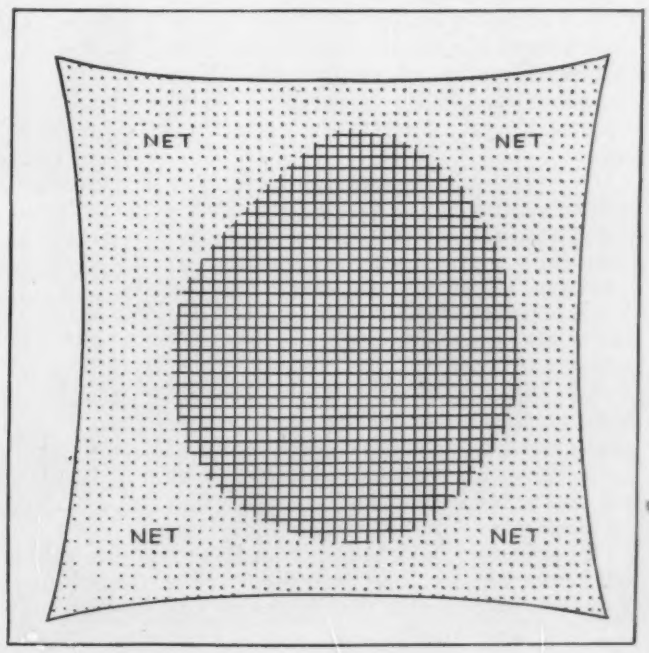
After being cut to exact dimensions, the plates of glass are heated to a high temperature and are tempered by properly regulated air currents blown perpendicular to or parallel with the plates. The rapid cooling sets up certain stresses in the glass: a compression force at the surface and a tension in the center. If the plate is subsequently exposed to a blow, the compressive force at the surface counteracts its effects. If the impact is so great that the compressive force will not withstand it, shearing stresses, perpendicular to the direction of the blow, are set up that spread the breakage toward the edges.

No defects in the manufacture of the glass can remain in the finished product, for any piece of glass not sufficiently hardened will break during the manufacturing process.

Sekurit glass will resist temperature fluctuations of great extent. A plate can be exposed to molten lead or can be heated to 268 degrees C. and then plunged into a salt bath at seven degrees below zero, without cracking either time. Neither vibration nor repeated impact have any harmful effect. A plate four feet by one was subjected to 800 vibrations per minute for over eight hours without any detectable change.

Tests for impact strength were made upon small squares of the glass at various temperatures. Steel balls were dropped from various elevations and the height required to break the squares was recorded. Plates a quarter of an inch thick, when placed horizontally, showed impact strengths of from 2.3 to 4.6 foot pounds. When supported at both ends, large rectangular plates broke only when the impact strength exceeded 14.5 foot pounds, but it required 36.3 foot pounds to shatter the strongest rectangle.

The market price of Sekurit glass is $1.60 per square foot. It is used in automobiles, street-cars, railroad coaches, and in laboratories and chemical plants requiring glass having a high resistance to heat.



This net, resembling a huge checkerboard, is built up of four-inch squares of varicolored muslin.

RESEARCH IN REVIEW

COURSE I
Civil Engineering

Measurement of the accelerations of severe earthquakes is one of the projects for which instruments are being developed in the recently opened seismographic laboratory of the Geodesy and Seismology department of Course I. One such instrument, a contact accelerometer, after having been developed satisfactorily in this laboratory, is now being used by the United States Coast and Geodetic Survey. Its function is to serve as a starting device for other accelerometers or seismographs.

One function of the new laboratory will be to test various forms of seismometers and accelerometers to obtain constants and to determine the quality of records and suitability of instruments for different purposes. To test models of engineering structures for the effect upon them of vibrations and for structural weaknesses will be another function. Experiments of the latter type will include a study of the relation of the period to the damage caused by vibrations.

Approximately twenty earthquakes have been recorded by the Wenner Seismograph, installed in July, 1932, at Camp Technology. Regular reports from this instrument are being sent to the United States Coast and Geodetic Survey for their study and records.

COURSE VI
Electrical Engineering

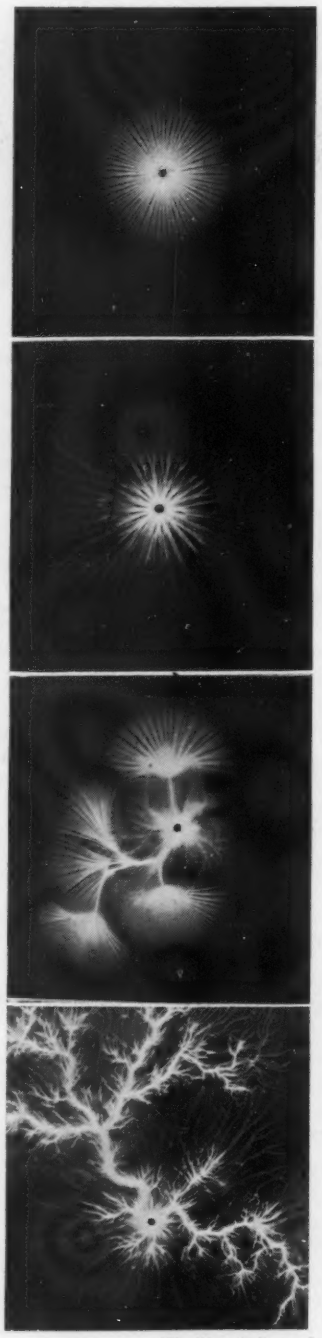
Without a good communication system, no city police force can be very effective. Boston's Police Department, realizing this fact, has commenced work on a coördinated telephone-teletype-radio system, for whose design Professor C. E. Tucker of the Massachusetts Institute of Technology Electrical Engineering Department is primarily responsible. New equipment is already being installed in three of the city's seventeen police divisions.

One phase of the work now under way involves an extension of the present call-box system; but it includes a good deal more than that. Each box, besides containing a telephone connected to the division police station by a special line, will be equipped with a "recall light" and a "citizens' hook."

The former of these devices is a signal lamp mounted on the box. By flashing all the recall lights in the district patrolled by any given man, a station will be able to call him to the nearest box and reach him by telephone.

The citizens' hook is rather an innovation for police call-boxes, but has long been used on fire alarm boxes. A switch, arranged so that it can be operated without the box being opened, will send a code signal to the station house, indicating which box's switch has been pulled. At the same time, it will cause all the recall lamps in the district to flash, bringing every policeman in the vicinity to the box nearest to him; the station operator will then announce which box has signalled, and which men should go to the scene.

Unusual flexibility will characterize the entire telephone system. For example, it will be possible for a patrolman in South Boston to communicate with the desk sergeant of the Boylston Street station or for a detective in Jamaica Plain to talk with Commissioner Hultman at Police Headquarters.



The Electric Journal

"SNOWFLAKES"

Electric impulses, applied to a sharp point in contact with a grounded photographic plate, pencilled these frost-like designs. In the top figure, the electrode was negative with respect to the plate; in the second, positive. Both are symmetrical. The last two were made with high potential and are unsymmetrical.

COURSE X
Chemical Engineering

Transmission of heat by direct radiation is very important from an industrial standpoint. The Fuels Research Laboratory is engaged in a study of a number of phases of this subject. These include: Theoretical and experimental determination of non-luminous gas radiation, radiation from luminous flames, application of the laws of photometry and illumination to industrial furnace design problems, study of emissivity of high-temperature alloy steels.

The continued and increasing use of pulverized fuels in industrial furnaces has made necessary a more thorough knowledge of the combustion of solid carbon in order that the correct shape and size of the combustion zone for these furnaces may be determined. A study of the phenomena of diffusion and chemical reaction occurring in the film surrounding a piece of burning carbon of definite geometrical shape is in progress.

By subjecting combustible gaseous mixtures to adiabatic compression to a temperature at which reaction is appreciable a study is being made of the mechanism of the combustion of gaseous fuels.

Work is going forward on a study of the temperature of flames and explosions. By use of the sodium *D*-line reversal method a determination of the temperatures attained in powder explosions is being made. Development and application of a two-color optical pyrometer is in progress for use with flickering, partially transparent flames.

By the use of sulfuric acid the olefin content of refinery or other "cracked" hydrocarbon gases may be hydrated to alcohols, and this method is being used today on an industrial scale to produce alcohols. The direct hydration of olefins to alcohols with water in a high-pressure, catalytic process has been actively studied in the Research Laboratory of Applied Chemistry. This work is being continued as a Doctor's thesis under laboratory supervision.

NETWORKS

(*Continued from page 7*)

we did not see, and we could not see, nor visualize from all that, the significance and beauty implied in these means of transportation of a seemingly living being, Electricity. These lines extended in eight directions like manacles of an octopus; their substations drawing in from the elements those charges which rejuvenated the system as the suction cups on the tentacles of the octopus draw in sustenance for their master. Thus these arms of the octopus serve it, as the conductors of our servant serve us. Here the stop is only brief since this station is almost 100 per cent automatic.

In the next town we visit a power plant where the chief has to stop to synchronize a dynamo (*i.e.*, cut a generator into a 60 cycle system without interrupting the system). It is a very ticklish job since the generator must be speeded up and slowed down until it is running at the same speed and the charges are changing direction at the same time as the rest of the system. Then a button is pressed which closes the horn-gap switches outside of the station. Usually several attempts are made since allowances must be made for the time it takes the relayed current to reach the horn-gaps and close them. If the man behind the switch is not experienced, he may cause a dip in the graph over the whole state. What do they mean, affect the whole state? Is this loop connected with the rest of the state? Yes. It certainly is. Let us take the occasion of a more distant tour as a chance to find out more about this.

As we leave the central district we note that there is still a high line visible between the trees. This is a new line which has just been built into the northwest, so that the steam plants may save coal by using current from the central district. On circling around on our way to Saranac Lake, we discover another line joining the Saranac district with the central. This is to help the central district in the summer time when its water power is scarce. At Albany we learn of the advantages of a 110,000 volt line along the Hudson to New York, where the steam plants can generate more than is needed for the short summer nights when many are in the north at the mountains, while the northern rivers are growing dry and population is increasing. Why not borrow current? They can pay it back in the winter when they have a surplus of water and the New York City steam plants are taxed to capacity. It is better to spend a little money on a high line than thousands on emergency overload equipment which may never be used. This is fine for state chain, but there is a line going east from Albany. How do they work this linking? Who pays for the borrowed current? There is a two-way meter on the state line, and at the end of the month the readings are subtracted, and the bill is sent to the company which has used the most. If the steam plants on Cape Cod should fail, the New England system would carry them; but, if they could not, they would ask the Niagara–Hudson, or they might even have to ask the Associated Gas and Electric in New York State to carry them. The power might actually come from Niagara Falls; it would not matter where it came from so long as someone in the system had consented to stand the load and boost up the current when the needle dipped.

In an emergency a supply of 20,000 kilowatts per hour would be available from the "floating power plant," Jacona. A radio call would send it steaming up

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the Atlantic coast, and it would soon be hooked in where the power was needed. This arrangement enables steam plants to shut down and clean boilers, providing they receive an authorized agreement from another company stating that they will carry the load. In case of crippling by storm the load may be carried by those outside the storm area.

Electrical inconsistency is dangerous. It may precipitate great financial loss, or cause inconvenience to theater goers, restaurant patrons, and everybody who lives in a modern manner. Service is the by-word, and developments are being made with that in mind. We are not yet the masters of Electricity; we may never be; yet we are taking long strides toward that objective.

TECHNOCRACY

(*Continued from page 3*)

treatment of technological unemployment. In graphic terms they describe the march of the machine as it proceeds through industry after industry leaving behind a growing multitude of displaced workers. So cleverly do they depict the havoc created by the mechanical juggernaut that the superficial or thoughtless reader is likely to be carried away. The array of examples presented seems formidable enough to convince even the most skeptical. But in their method of dealing with this question the "scientists" are most unscientific; their samples are carefully chosen to prove their thesis. If they would enlarge the scope of their investigation they would find that, while workmen are being displaced in some industries, new jobs are being created in others and that, taking the field of employment as a whole, the number of gainfully employed per thousand of the population, except for certain short periods of time, shows no sign of diminution.

When Mr. Frank Arkright predicts that employment "will continue to decrease, be times good or bad,"* he apparently ignores not only the known facts of experience, but also the almost universally accepted economic analysis of the situation. The introduction of machinery reduces expenses of production, and consumers, not having to pay as much as before to purchase the product, have money to spend on something else. With this money they give employment to labor. The cheapening of goods through mechanization releases buying power which provides work in some other branch of industry. The great problem of technological unemployment is to move those who have been thrown out of work by machinery into the industries where released buying power has increased the demand for labor. Without in the least minimizing the difficulty of making this adjustment, one can readily see that the enforced idleness arising from mechanical invention is not cumulative. The terrifying prospect of ever increasing unemployment is nothing but an unsubstantial apparition that haunts the darkness of ignorance. In the light of rational analysis it dissolves.

The Technocrats also affirm that the credit system has outlived its usefulness; that, since saving and investing are no longer necessary, financial institutions can be dispensed with. "So long as scarcity existed," writes Mr. Loeb, "this throwing back of a part of income into further production was desirable and necessary. But scarcity has been abolished in the United States."† The contention seems to be that, since business enterprises cannot market all the goods they are capable of producing, society has left behind the stage of scarcity and passed into an era of plenty. Here is another example of faulty analysis. There is not the remotest probability of a general glut of commodities. Our troubles arise from the failure of producers to sell their output at prices high enough to cover the costs of production: the prices of cost items are out of line with selling prices. The price of a commodity, of course, is determined partly by the quantity produced; and the existing price maladjustment may be regarded as a result of producing too much of some things. But it may also be regarded as the result of producing too little of other things. In short, the root of the trouble lies not in a super-abundance of all commodities and services, but rather in the failure to maintain a proper relationship between the outputs of different commodities and services. To state that scarcity has been abolished in the United States is nonsense. So long as we maintain a balanced output, there is no point this side of the millennium at which we shall be compelled to halt the expansion of production because of a superfluity of enjoyable goods.

It is to be expected that, as time goes on and our productive power increases, we shall devote a smaller portion of our resources to making the crude necessaries of life and a growing portion to conveniences, luxuries and things which minister to our aesthetic and spiritual wants. "Nobody fears a glut in the market for culture. We cannot go too far in expanding those services which yield the durable satisfactions of life. . . . It is true, as the terrified technocrats say, that a single turbine now has a capacity of 300,000 horsepower. But it has not a single horsepower capacity for teaching school, or editing a newspaper, or creating beauty, or caring for the sick, or governing a city or ministering to human souls which are weary and heavy laden. The services most needed by humanity are individualistic by nature. They cannot be furnished by mass production. Their value cannot be measured in ergs or joules or calories."‡

3. A Program of Reform. A price system such as ours, that is thrown out of balance periodically, is not perfect, and the sponsors of Technocracy in pointing out the imperfections of the existing scheme of things

* Arkright, Frank, "The A B C of Technocracy," p. 46 (Harper, N. Y., 1933).

† Loeb, Harold, "Life in a Technocracy," p. 17 (Viking Press, N. Y., 1933).

‡ Foster, W. T., *Boston Transcript*, January 14, 1933.

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will find comparatively little disagreement. But while we may agree with them that capitalism is sick, we are are not compelled by this agreement to endorse the remedies which they prescribe. Their prescription, in brief, is to abolish the price system and place the engineers in control. "The state, or perhaps it should be called the industrial system, since it has few characteristics of a political state, will guarantee each member of the community a proportionate share of the energy production of the community. The consumer will decide how and when he accepts payment; motor rides or caviar, books or housing, all being available on demand. The valuation of each, being an energy valuation, is an exact figure determined by the methods of physical science and independent of supply and demand. . . . To keep track of supplies a certificate would be issued to each human unit. This would entitle him to his energy allotment and specify his exact place and function in the industrial system."* This mechanical paradise would be governed by scientific experts because "how best to produce and distribute the products of man's efforts is an engineering problem, for each detail of which, there is always a right answer."†

Of course, it is impossible to appraise such a far-reaching and revolutionary program in a few words. Take the Russian system, substitute the engineering profession for the communist party, remove the ruble and put in the erg, in the place of the ration card insert the allotment certificate, and then you have Technocracy. If you are an engineer, try to suppress your feeling of satisfaction with a proposal so flattering to you and your profession, and consider carefully some of the difficulties and perils of the plan. Consider the many problems involved in organizing the numerous and varied activities of a nation, in distributing work and wealth amongst the different individuals, districts and classes, in coördinating all their activities, in providing incentives to stimulate men and women to labor, in deciding between the claims of an infinite variety of consumers' needs, habits and tastes. How many of these problems are essentially engineering problems? What likelihood is there of inducing people to submit to an engineering dictatorship? Turn these questions over in your mind, these and the many others which will readily occur to you, and you will perceive the absurdity of this fantastic scheme.

Two great questions are likely to confront us in the future. How shall we organize to ensure that the resources of society are used to satisfy the basic wants of al consumers before these resources are diverted to the plroduction of conveniences and luxuries for the few? How shall we divide the fruits of economic progress between the satisfactions of increased leisure and the pleasures obtainable from additional quantities of goods? Answers to these questions are not clear at the moment, and it may be asserted that the capitalistic system will have to be modified, or even displaced, before we shall arrive at satisfactory answers. But it would be foolish to discard what we have and, in a fit of panic or impatience, grasp at a chimerical alternative which ignores the realities of life. A new order, if it is to come, will not be constructed in a day or a generation; neither will it be built to the specifications of a small group of alarmists with a pseudo-scientific formula for social perfection.

That the engineering profession is entitled to an increasingly important place in the administration of social life, there is not the slightest doubt. The progress of mechanization is rapidly enlarging the field of

* "Life in a Technocracy," pp. 40, 41.
† *Ibid.*, p. 76.

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the engineer's activity in business, while the extension of government control over industry is demanding his greater participation in political affairs. Whether in business or in politics or in any other sphere of life, if the job to be done is an engineering job, it should be given to the engineer. A politician or an economist in charge of an engineering project is like a monkey with a watch. For the same reason, however, if the problem is one for the banker, lawyer, artist, business manager, diplomat, accountant, teacher or economist, it would be unwise to assign it to the engineer. We shall develop the most efficient system of social control, not by entrusting the work to any one type of expert, but by utilizing the various specialists of the community to perform those tasks for which they are qualified by nature, training and experience.

CORRECTION

In view of the desire of Technocracy to be known for the accuracy of its figures, Mr. Ward wishes to call attention to an error appearing in "Society: A Problem in Thermodynamics," due to his having confused two similar types of engines. Top of page 147, January issue, last two lines, should read, "which delivered 2500 h.p., equivalent on a 24-hour basis to the work of 75,000 men." The figures given (7,800 h.p. and 234,000 men) are correct but apply to the marine triple expansion engine development of the "nineties," and it *does* represent the maximum rate of output of energy conversion for the reciprocating engine.

LUMBERING

(*Continued from page 11*)

the track. The cook house is nearby as are also a general store and office. Bath houses and latrines are also provided, but sanitary plumbing is of the New Hampshire variety. Besides the men who live in the bunk houses, there are usually several thousand other inhabitants. Fortunate indeed are the loggers that their daytime activities make them sound sleepers at night. Bed bugs are most unpleasant companions.

The habits of the men are unusual. They save their money while in camp by making their clothing serve long after it has outlived its usefulness and then go to town and spend in a few days all they have saved. In the days of the saloon the average time spent in town was two days each trip with two to three months between trips. After prohibition and before bootlegging became well established, they stayed in town for several weeks. They do not go back to the woods until all their money is gone, and they can not do a real job of throwing away the proceeds until they become drunk. This condition has since been corrected. They can now come to town, get themselves into the proper frame of mind very quickly, and begin spending their savings. Then they are again on their way to the woods with perhaps a couple pairs of new socks and a shirt to show for their savings.

GOLD MINING

(*Continued from page 5*)

With the approaching exhaustion of reserves that can be worked under present conditions, and the consequent menace of large unemployment and loss of all gold mining taxes, there can be little doubt that political expediency will work to lower this burden.

In Siberia, large reserves of gold are known to exist. It is not impossible that these may be aggressively developed by an industrially minded nation within the next few decades.

Finally, any change in economic relations which would raise the price of gold relative to other things would tend to increase ore reserves and keep up the production curve. The at least temporary effect of South Africa in going off the gold standard is an example. It seems likely that if the present economic structure of the world is maintained, that when a marked fall in the production curve of gold takes place, prices should fall relative to gold and automatically new reserves will be made available. Whether such a state of affairs will be allowed to take place or would be desirable is another matter.

INCH

(*Continued from page 9*)

mass and hence with a single atom can be deduced. The volume per atom tells us very closely the diameter of the atom and the distances between the centers of adjacent atoms. The agreement of these values is such that there can be little doubt as to the significance of the measurements.

While it cannot be stated that this method of measurement has a direct commercial application at present, the results are none the less important. Although such measurements are not in the least confined to problems of the metallic state, the student of physical metallurgy has come to use this research tool very extensively. Many of the physical properties of metals and metallic alloys depend in a fundamental way upon the manner in which the atoms are placed with respect to one another. In order to develop an alloy with the most suitable properties for a specified purpose, cut-and-try methods are no longer sufficient. It is necessary to find out the explanations of the observed properties, and with these clearly set forth, the development of the desired alloy follows directly. It is not always easy to discover such explanations, and it is essential that the most powerful tools available be employed. Probably the most important item of information in this connection is the actual distance between the atoms.

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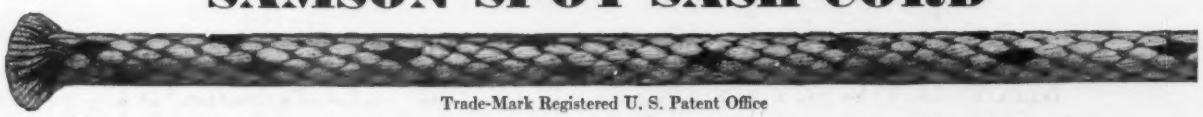

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